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742A Series

RESISTANCE STANDARDS

Instruction Manual

FLUKE

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RESISTANCE STANDARDS

Instruction Manual

P/N 850255
September 1988 Rev. 1 4/89
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FLUKE

WARRANTY

John Fluke Mfg. Co., Inc. (Fluke) warrants this instrument to be free from defects in material and workmanship under normal use and service for a period of 1 year from date of shipment. Software is warranted to operate in accordance with its programmed instructions on appropriate Fluke instruments. It is not warranted to be error free. This warranty extends only to the original purchaser and shall not apply to fuses, computer media, batteries or any instrument which, in Fluke's sole opinion, has been subject to misuse, alteration, abuse or abnormal conditions of operation or handling.

Fluke's obligation under this warranty is limited to repair or replacement of an instrument which is returned to an authorized service center within the warranty period and is determined, upon examination by Fluke, to be defective. If Fluke determines that the defect or malfunction has been caused by misuse, alteration, abuse, or abnormal conditions of operation or handling, Fluke will repair the instrument and bill the purchaser for the reasonable cost of repair. If the instrument is not covered by this warranty, Fluke will, if requested by purchaser, submit an estimate of the repair costs before work is started.

To obtain repair service under this warranty purchaser must forward the instrument, (transportation prepaid) and a description of the malfunction to the nearest Fluke Service Center. The instrument shall be repaired at the Service Center or at the factory, at Fluke's option, and returned to purchaser, transportation prepaid. FLUKE ASSUMES NO RISK FOR IN-TRANSIT DAMAGE.

THE FOREGOING WARRANTY IS PURCHASER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, OR FITNESS FOR ANY PARTICULAR PURPOSE OR USE. FLUKE SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OR LOSS WHETHER IN CONTRACT, TORT, OR OTHERWISE.

CLAIMS

Immediately upon arrival, purchaser shall check the packing container against the enclosed packing list and shall, within thirty (30) days of arrival, give Fluke notice of shortages or any nonconformity with the terms of the order, If purchaser fails to give notice, the delivery shall be deemed to conform with the terms of the order.

The purchaser assumes all risk of loss or damage to instruments upon delivery by Fluke to the carrier. If an instrument is damaged in transit, PURCHASER MUST FILE ALL CLAIMS FOR DAMAGE WITH THE CARRIER to obtain compensation. Upon request by purchaser, Fluke will submit an estimate of the cost to repair shipment damage.

Fluke will be happy to answer all questions to enhance the use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX C9090, EVERETT, WA 98206,

INTRODUCTION

The 742A Series are small, light, rugged resistance standards. The standards require no temperature-controlled air or oil bath. The 742A Series are well suited for use as the following:

- Working standards
- Portable transfer standards
- Calibration support for the Fluke 5700A Calibrator

Stability and temperature coefficients of the 742A Series make them ideal for easy transport to and operation in any working environment within the range of 18 to 28°C. The standards come with six-month and one-year uncertainty specifications. Depending on the accuracy required, a 742A can be recertified at intervals based on either specification.

Each 742A comes with a Report of Calibration and a rear panel label showing the measured value. The rear panel also has a Fluke Primary Standards Lab calibration label, labels that show temperature coefficient alpha and beta centered on 23°C, and the standard's serial number.

NOTE

Refer to "How Temperature Correction Factors are Calculated," further on in this manual for definitions of alpha and beta.

SPECIFICATIONS

Table 1 lists specifications for the available 742A Series Resistance Standards.

Table 1. 742A Series Resistance Standard Specifications

MODEL	NOMINAL RESISTANCE AT 23°C	TIME STABILITY STABILITY		CALIBRATION UNCERTAINTY	MAXIMUM DEVIATION FROM THE 23°C VALUE (18 TO 28°C)	MAXIMUM CURRENT (VOLTAGE)	+1 PPM ERROR ADDER WHEN CURRENT EXCEEDS THE FOLLOWING
		180 DAY	1 YEAR				
742A-1	1Ω	±5.0 ppm	±8.0 ppm	±1.0 ppm	3.0 ppm	500 mA (500 mV)	200 mA
742A-1.9	1.9Ω	±5.0 ppm	±8.0 ppm	±1.0 ppm	3.0 ppm	200 mA (380 mV)	100 mA
742A-10	10Ω	±5.0 ppm	±8.0 ppm	±1.0 ppm	3.0 ppm	100 mA (1V)	20 mA
742A-100	100Ω	±4.0 ppm	±6.0 ppm	±1.0 ppm	3.0 ppm	20 mA (2V)	5 mA
742A-1k	1 kΩ	±4.0 ppm	±6.0 ppm	±1.5 ppm	2.0 ppm	10 mA (10V)	2 mA
742A-10k	10 kΩ	±2.5 ppm	±4.0 ppm	±1.0 ppm	1.5 ppm	3 mA (30V)	600 μA
742A-19k	19 kΩ	±2.5 ppm	±4.0 ppm	±1.5 ppm	2.0 ppm	1.5 mA (28.5V)	600 μA
742A-100k	100 kΩ	±4.0 ppm	±6.0 ppm	±2.5 ppm	2.0 ppm	1 mA (100V)	400 μA
742A-1M	1 MΩ	±6.0 ppm	±8.0 ppm	±5.0 ppm	2.0 ppm	100 μA (100V)	100 μA
742A-10M	10 MΩ	±6.0 ppm	±9.0 ppm	±10.0 ppm	3.0 ppm	20 μA (200V)	20 μA
742A-19M	19 MΩ	±8.0 ppm	±10.0 ppm	±20.0 ppm	4.0 ppm	10 μA (190V)	10 μA

GENERAL SPECIFICATIONS:

Accuracy: The initial resistance is trimmed to ± 2 ppm of nominal. The measured value is printed on the rear panel.

Retrace Error (Hysteresis): 23°C-18°C-23°C cycle: Negligible resistance shift
23°C-28°C-23°C cycle: Negligible resistance shift
23°C-0°C-23°C cycle: <2 ppm resistance shift
23°C-40°C-23°C cycle: <2 ppm resistance shift

Operating Temperature Range: 23 ±5°C

Storage Temperature Range: 0 to 40°C

Report of Calibration: The report of calibration includes a table of resistance values in 0.5° increments from 18 to 28°C.

Size: 8.6 cm H x 10.5 cm W x 12.7 cm L (including binding posts)
(3.4 in H x 4.15 in W x 5 in L (including binding posts))
Binding posts; 2.5 cm (1.0 in)

Weight: 0.68 to 0.91 kg (1.5 to 2.0 lbs), depending on model

DESIGN AND CONSTRUCTION NOTES

The 742A Series are constructed of arrays of Fluke wirewound precision hermetically-sealed resistors. No adjustable resistors of any kind are used.

Each 742A is built with a temperature coefficient near zero at 23°C. To further reduce errors caused by temperature changes, the binding posts are constructed of low-thermal emf material.

FEATURES

Figure 1 shows a front panel view. Figure 2 shows a rear panel view. Table 2 describes binding post functions. Table 3 describes the rear panel labels.

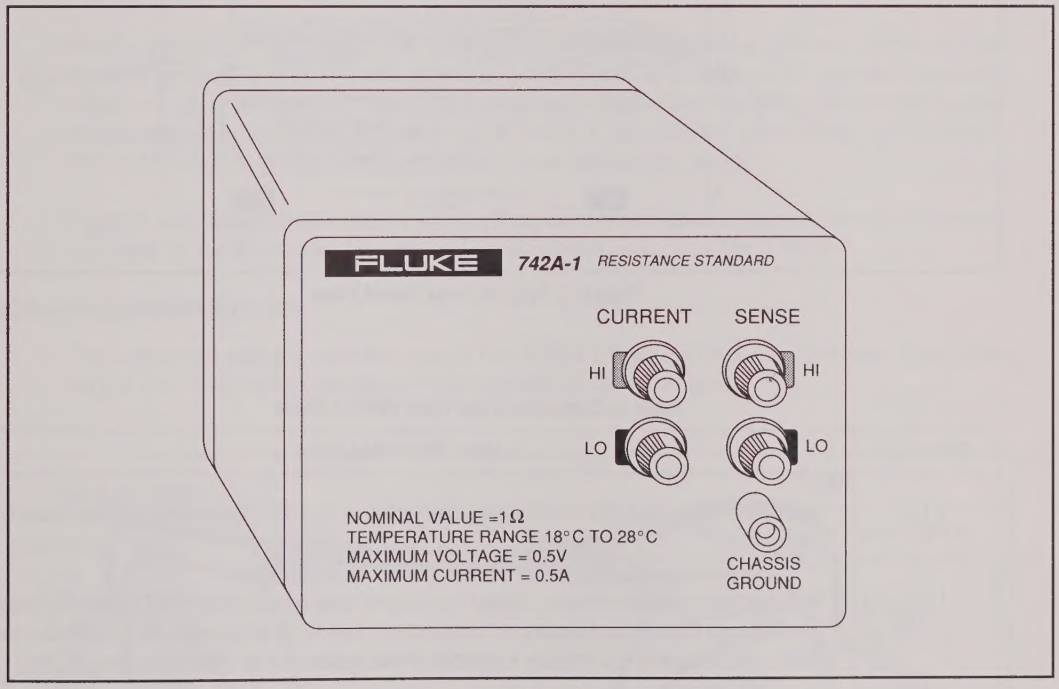

Figure 1. Typical Front Panel View

Table 2. Functions of the Binding Posts

742A BINDING POST	FUNCTION
CURRENT HI	Input for the current source from an ohmmeter
CURRENT LO	Input for the current source from an ohmmeter
SENSE HI	Measurement point for a four-wire ohmmeter
SENSE LO	Measurement point for a four-wire ohmmeter
CHASSIS GROUND	Connected to the case for shielding

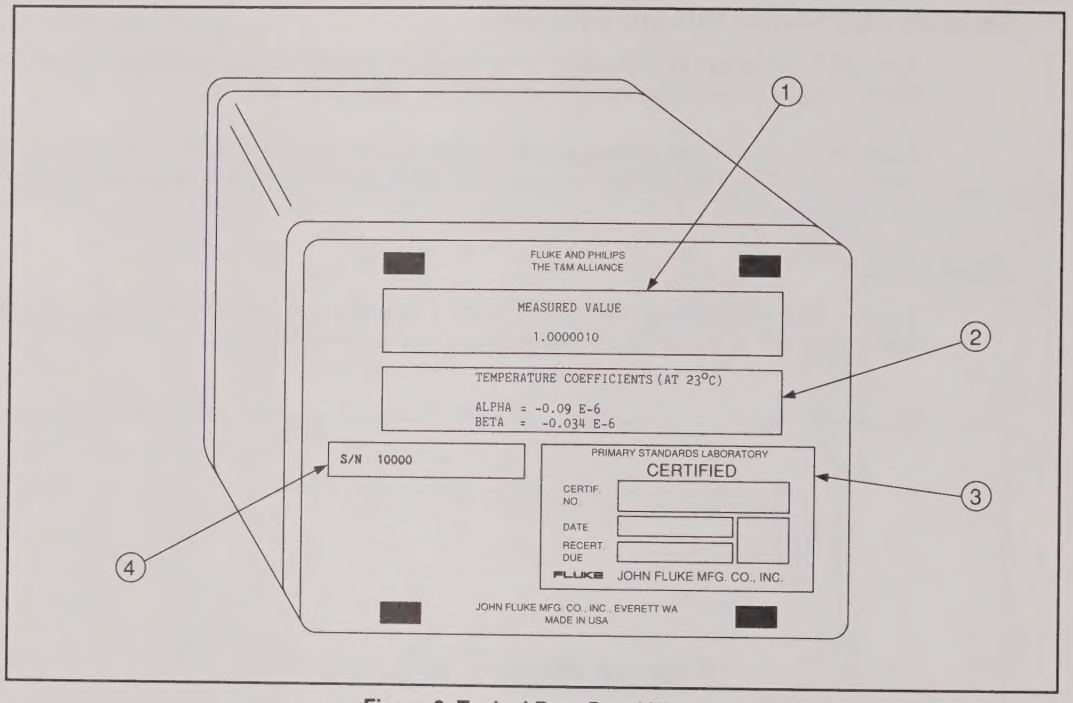

Figure 2. Typical Rear Panel View

Table 3. Contents of the Rear Panel Labels

REF NO.	LABEL INFORMATION
(1)	Measured value label. Shows the measured value at 23 ± 0.6°; the same as on the Report of Calibration.
(2)	Temperature coefficient label. Shows alpha and beta centered on 23°C. Refer to "How Temperature Correction Factors are Calculated," further on in this manual for definitions of alpha and beta, and the formula to predict exact resistance at different temperatures.
(3)	Fluke Primary Standards Lab Calibration Label documents traceability to the U.S. National Bureau of Standards.
(4)	Serial number label. Shows the standard's serial number. This number and the full model number (i.e., 742A-1) positively identify a particular unit.

OPERATING NOTES

This part of the manual explains operational and environmental considerations for the 742A Series. Follow these guidelines when operating or storing the resistance standard. Precautions for handling are under "Care and Maintenance."

Connecting to the 742A Series

CAUTION

Do not apply voltages above the maximum voltage printed on the front panel. Excessive voltage can cause a permanent shift in resistance value or damage.

The specifications for models with CURRENT and SENSE binding posts require four-wire connections to the standard. Use these binding posts as described in Table 2.

For the case to act as a shield, the CHASSIS GROUND binding post must be connected to earth ground or instrument guard at some point in a calibration system. Normally when two or more instruments with guards are connected together, the use of a single common grounding point avoids ground loops. If applicable, ground the 742A CHASSIS GROUND binding post to that common grounding point.

Figure 3 shows a typical connection to a four-wire ohmmeter. Figure 4 shows the connection used to calibrate the 1Ω internal resistance standard in the 5700A.

Cable Recommendations

For optimum results, use two sets of the Fluke 5440A-7004 Low Thermal Test Leads, which are designed to reduce errors caused by thermal emfs.

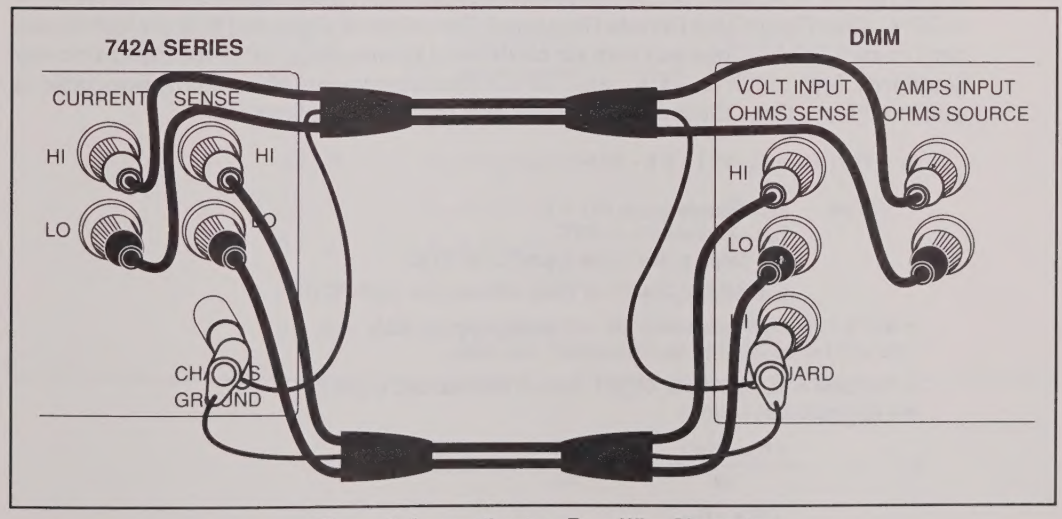

Figure 3. Connection to a Four-Wire Ohmmeter

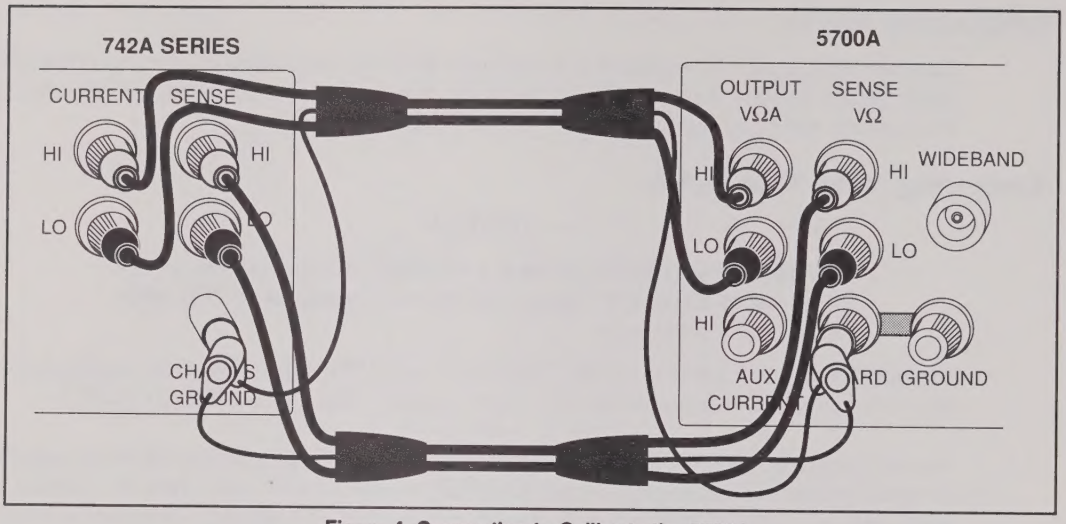

Figure 4. Connection to Calibrate the 5700A

Operating Temperature Range

You can use the 742A Series in ambient temperatures between 18 and 28° C. To predict the deviation from nominal at temperatures other than 23° C, use the temperature characterization table provided with each unit. The table shows the calculated value and the deviation from nominal at temperatures between 18 and 28° C in half-degree increments. An example of this table is included as Table 4.

How Temperature Correction Factors are Calculated

A label on the rear panel shows temperature coefficient factors alpha and beta centered on 23° C. (See Figure 2 for the label location.) The values of alpha and beta are individualized for each 742A. Alpha and beta are established by measurement in the Fluke Primary Standards Lab at 18° C, 23° C, and 28° C. The temperature characterization table is generated from these three measurements and the following formula:

$$R_t = R_{23} [1 + \alpha (t - 23) + \beta (t - 23)^2]$$

Where, R_t = Resistance at t°C
R_{23} = Resistance at 23°C
α = Slope of the curve (ppm/°C) at 23°C
β = Rate of change of slope of the curve (ppm/°C²)

α and β are constants which do not change appreciably over time and hence need to be determined only once.

In the case of the example 742A-1 used in this manual, α and β are calculated as follows:

$$\alpha = \frac{(R_{28} - R_{18})}{\Delta t} = \frac{-0.9 \text{ E-6}}{10} = -0.09 \text{ E-6}$$

$$\beta = \frac{\frac{(R_{28} + R_{18})}{2} - R_{23}}{\left(\frac{\Delta t}{2}\right)^2} = \frac{-0.85 \text{ E-6}}{25} = -0.034 \text{ E-6}$$

Where, R_{28} = Resistance at 28°C
R_{18} = Resistance at 18°C
R_{23} = Resistance at 23°C
Δt = (28 - 18) = 10

Table 4. Example 742A-1 Temperature Characterization Chart

Test Number: XXXX
Date: 04-Aug-88
Page 2 of 2

Serial No.: XXXXXX
Alpha = -0.090 E-6
Beta = -0.034 E-6

Temp (Celsius)	Resistance (OHMS)	Dev from nominal (in ppm)
18.0	1.0000006	0.6
18.5	1.0000007	0.7
19.0	1.0000008	0.8
19.5	1.0000009	0.9
20.0	1.0000010	1.0
20.5	1.0000010	1.0
21.0	1.0000010	1.0
21.5	1.0000011	1.1
22.0	1.0000011	1.1
22.5	1.0000010	1.0
23.0	1.0000010	1.0
23.5	1.0000009	0.9
24.0	1.0000009	0.9
24.5	1.0000008	0.8
25.0	1.0000007	0.7
25.5	1.0000006	0.6
26.0	1.0000004	0.4
26.5	1.0000003	0.3
27.0	1.0000001	0.1
27.5	0.9999999	-0.1
28.0	0.9999997	-0.3

Figure 5 shows a graph of the value of the 742A-1 represented by the sample temperature characterization chart (Table 4). To illustrate use of the formula, calculations for resistance at 20° C and 26° C are shown. You can see that using the formula shown with alpha and beta you get the same value as in the characterization table.

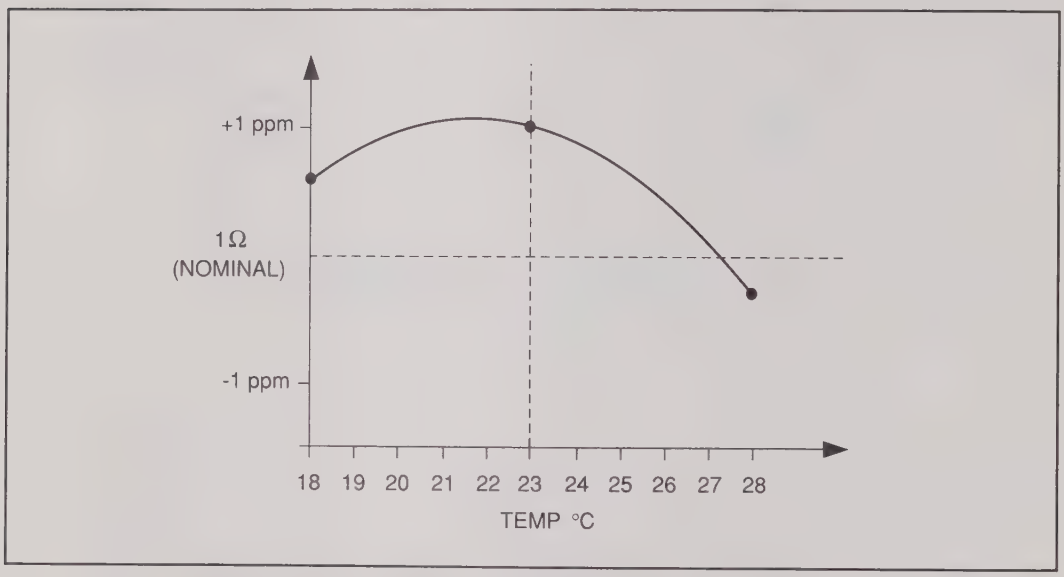

Figure 5. Graph of Resistance VS. Temperature for Sample 742A-1

$R_t = R_{23} [1 + \alpha (t - 23) + \beta (t - 23)^2]$
At = 20°C,
$R_{20} = 1.0000010 [1 + (-0.09 E-6) (-3) + (-0.034 E-6) (-3)^2]$
$= 1.0000010 (1.0000003 - 0.0000003)$
$= 1.0000010 (1.0000000)$
$= 1.0000010\Omega$

$R_t = R_{23} [1 + \alpha (t - 23) + \beta (t - 23)^2]$
At = 26°C,
$R_{26} = 1.0000010 [1 + (-0.09 E-6) (3) + (-0.034 E-6) (3)^2]$
$= 1.0000010 (1 - 0.0000003 - 0.0000003)$
$= 1.0000010 (1 - 0.0000006)$
$= 1.0000004\Omega$

Storage Temperature Range

To maintain accuracy within the specified limits, do not subject the 742A Series to temperatures below 0° C or above 40° C. If exposure to temperatures outside this range is unavoidable, you can minimize the adverse effects by doing the following:

- Keep the standards in the optional transit case (Option 742A-7002). The transit case is insulated and helps protect the standards during short-term temperature extremes.
- Keep exposure to temperature extremes brief.

CARE AND MAINTENANCE

The only maintenance procedure for the 742A Series is occasional cleaning. The following text gives cleaning instructions and precautions for handling.

Cleaning the 742A Series

To keep the 742A Series looking like new, clean the outer surfaces using a soft cloth slightly dampened with water or a non-abrasive mild cleaning solution that does not harm plastics.

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. They can damage the plastic materials used in the resistance standard.

Precautions for Handling

The 742A Series are designed for mechanical stability, but do not abuse the standard with excessive shock. Avoid temperature extremes as mentioned under "Storage Temperature Range". When you transport the standard, it is recommended that you use the Option 742A-7002 Transit Case for shock and temperature protection. The case holds two 742A Series Resistance Standards.

SERVICING INFORMATION

Because the 742A Series are certified and non-adjustable resistance standards, they are considered non-user repairable. If the unit is damaged, it must be returned to the factory for repair and recalibration.

RECERTIFICATION

For recertification, send the resistance standard to a Fluke technical center. For a nominal fee, Fluke will remeasure and recertify the value of your 742A based on comparison to standards traceable to the U.S. National Bureau of Standards. A new temperature characterization chart is provided on recertification. If you wish, you can record the changes at each recertification and use this data to more closely predict the performance of your 742A. A list of sales and service centers is located near the end of this manual.

U.S. Service Locations

California
Fluke Technical Center
16969 Von Karman Ave., Suite 100
Irvine, CA 92714
Tel: (714) 863-1723

Fluke Technical Center
46610 Landing Parkway
Fremont, CA 94538
Tel: (415) 651-5112

Colorado
Fluke Technical Center
14180 East Evans Ave.
Aurora, CO 80014
Tel: (303) 695-1000

Florida
Fluke Technical Center
940 N. Fern Creek Avenue
Orlando, FL 32803
Tel: (407) 896-4881

Illinois
Fluke Technical Center
1150 W. Euclid Ave.
Palatine, IL 60067
Tel: (312) 705-0500

Maryland
Fluke Technical Center
5640 Fishers Lane
Rockville, MD 20852
Tel: (301) 770-1576

New Jersey
Fluke Technical Center
E. 66 Midland Ave.
Paramus, NJ 07652
Tel: (201) 599-9500

Texas
Fluke Technical Center
1801 Royal Lane, Suite 307
Dallas, TX 75229
Tel: (214) 869-0311

Washington
Fluke Technical Center
1420 75th St SW
Everett, WA 98203
Tel: (206) 356-5560

International

Argentina
Coasin S.A.
Virrey del Pino 4071 DPTO E-65
1430 CAP FED
Buenos Aires, Argentina
Tel: 54 1 522-5248

Australia
Philips Customer Support
Scientific and Industrial
23 Lakeside Drive
Tally Ho Technology Park
East Burwood,
Victoria 3151 Australia

Philips Customer Support
Scientific & Industrial
25-27 Paul St. North/ PO Box 119
North Ryde N.S.W. 2113
Australia
Tel: 61 2 888-0423

Austria
Oesterreichische Philips
Industrie GmbH Technischer
Kundendienst
Unternehnmensbereich
Prof. System
Triesterstrasse 66
A-110 Austria
Tel: 43 222-60101

Belgium
Philips & MBLE Associated S.A.
Scientific & Industrial Div
80 Rue des deux Gares B-1070
Brussels, Belgium
Tel: 32 2 525 6111

Brazil
Hi-Tek Electronica Ltda.
Al. Amazonas 422 Alphaville,
CEP 06400 Barueri
Sao Paulo, Brazil
Tel: 55 11 421-5477

Canada
Fluke Electronics Canada Inc.
400 Brittania Rd. East, Unit #1
Mississauga, Ontario L4Z 1X9
Tel: 416-890-7600

Fluke Electronics Canada Inc.
7018 Cote de Liesse
St. Laurent, Quebec H4T 1E7
Canada
Tel: 731-8564

Fluke Electronics Canada Inc.
6815 8th St. N.E., Suite 135
Calgary, Alberta T2E 7H7
Canada
Tel: (403) 295-0822

Chile
Intronica Chile Ltda.
Casilla 16228
Santiago 9, Chile
Tel: 56 2 2321886

China, Peoples Republic of
Instrimpex - Fluke Service Center
57, Xisi Dong Da Jie
Xicheng-qu
P.O. Box 9085
Beijing
People's Republic of China
Tel: 86 01 65-7281

Colombia
Sistemas E Instrumentacion, Ltda.
Carrera 13, No. 37-43, Of. 401
Ap. Aereo 29583
Bogota DE, Colombia
Tel: 57 232-4532

Denmark
Philips A/S
Technical Service I & E
Strandlodsvej 1A
PO Box 1919
DK-2300 - Copenhagen S.
Denmark
Tel: 45 1 572222

Ecuador
Proteco Coasin Cia., Ltda.
P.O. Box 228-AAve. 12 de Octubre
2285 y Orellana
Quito, Ecuador
Tel: 593 2 529684

Egypt and Sudan
Electronic Engineering
Liaison Office
P.O. Box 2891 Horreya
11361 Heliopolis
Cairo, Egypt
Tel: 202 695705

Finland
Instrumentarium Elektroniikka
P.O. Box 64, Vitikka 1
02631 ESPOO 63
Finland
Tel: 358-0-5281

France
S.A. Philips Industrielle
et Comerciale
Science et Industrie
105 Rue de Paris B.P. 62
93002 Bobigny Cedex
France
Tel: 33149428040

Germany (F.R.G.)
Philips GmbH
Unternehmensbereich Elektronik
fur Wissenschaft und Industrie
Service VSF
Oskar-Messter-Strasse 18
8045 Ismaning
West Germany
Tel: 49 89 9605-239

Great Britain
Philips Scientific Test
& Measurement Division
Colonial Way
Watford Hertfordshire WD2 4TT
United Kingdom
Tel: 44 923-240511

Greece
Philips S.A. Hellenique
11, Vrassida St.
Athens 612, Greece
Tel: 30 1 721140

Hong Kong
Schmidt & Co (H.K.) Ltd.
18th Fl., Great Eagle Centre
23 Harbour Road
Wanchai, Hong Kong
Tel: 852 58330-222

India
Hinditron Services Pvt. Ltd
1st Floor, 17-B, Mahal
Industrial Estate
Mahakali Road Andheri East
Bombay 400 093, India
Tel: 91 22 6300043

Hinditron Services Pvt. Ltd.
33/44A Raj Maha Villas Extn.
8th Main Road
Bangalore 560 080, India
Tel: 91 812 363139

Hinditron Services Pvt. Ltd.
Field Service Center
Emerald Complex 1-7-264
5th Floor
114 Sarojini Devi Road
Secunderabad 500 003, India
Tel: 91 842 821117

Hindtron Services Pvt. Ltd.
15 Community Centre
Panchshila Park
New Delhi 110 017, India
Tel: 91 011 6433675

Indonesia
P.T. Lamda Triguna
P.O. Box 6/JATJG
Jakarta 13001, Indonesia
Tel: 62 21 8195365

Ireland
Philips Scientific
Test & Measurement Division
Colonial Way
Watford, Hertsfordshire
WD2 4TT, United Kingdom
Tel: 44 923 40511

Israel
R.D.T. Electronics Engineering Ltd.
P.O. Box 43137
Tel Aviv 61430
Israel
Tel: 972 3 483211

Italy
Philips S.p.A.
Sezione S & I, T & M Dept.
Viale Elvezia 2
20052 Monza, Italy
Tel: 39 39 3635 1

Japan
John Fluke Mfg. Co., Inc.
Japan Branch
Sumitomo Higashi Shinbashi Bldg.
1-1-11 Hamamatsucho
Minato-ku, Tokyo 105, Japan
Tel: 81 3 434-0181

Korea
Myoung Corporation
Yeo Eui Do P.O. Box 14
Seoul 150, Korea
Tel: 82 2 784-9942

TECHNICAL SERVICE CENTERS

Malaysia
Mecomb Malaysia Sdn. Bhd.
P.O. Box 24
46700 Petaling Jaya
Selangor, Malaysia
Tel: 60 3 774-3422

Mexico
Mexicana de Electronica
Industrial, S.A. (Mexel)
Diagonal No. 27
Entre Calle de Eugenia Y Ave
Colonia del Valle
C.P. 03100, Mexico
Tel: 90 5 660-4323

Netherlands
Nederlandse Philips
Badrijven B.V.
Building TQIII-4, P.O. Box 218
5600 MD Eindhoven
The Netherlands

Philips Nederland
Business Unit: Test & Meetapparaten
Hoerveneweg 55A
5017 AD Tilburg
Postbus 115, 5000 AC Tilburg
The Netherlands

New Zealand
Philips Customer Support
Scientific & Industrial Division
2 Wagener Place - PO Box 41021
Mt. Albert
Auckland, New Zealand
Tel: 65 4 735735

Norway
Morgenstierne & Co. A/S
Konghellegate 3
P.O. Box 6688, Rodelokka
Oslo 5, Norway
Tel: 47 2 356110

Pakistan
International Operations (PAK) Ltd.
505 Muhammadi House
I.I. Chundrigar Road
P.O. Box 5323
Karachi 2, Pakistan
Tel: 92 21 221127

Peru
Importaciones Y Representaciones
Electronicas S.A.
Avda. Franklin D. Roosevelt 105
Lima 1, Peru
Tel: 51 14 288650

Philippines
Spark Radio and Electronics Corp.
Greenhills, P.O. Box 610
San Juan, Metro-Manila 3113
Philippines
Tel: 63-2-775192

Portugal
Decada Espectral,
Equipamentos de Electronica e
Cientificos, SARL.
Av. Bombeiros Voluntario, Lote 102B
Miraflores/Alges
1495 Lisboa, Portugal
Tel: 351 1 410 3420

Singapore
Rank O'Connor's Singapore
(PTE) Ltd. O'Connor House
98 Pasir Panjang Road
Singapore 0511
Republic of Singapore
Tel: 65 4737944

South Africa
South African Philips
(Pty) Ltd. Service Dept.
195 Main Rd
Martindale, Johannesburg, 2092
South Africa
Tel: 27 11 470-5255

Spain
Equipos Y Sistemas S.A. (ESSA)
C/Apolanio Morales, 13B
Madrid 16, Spain
Tel: 4580150

Philips Iberica S.A.E.
Depto. Tecnico Instrumentacion I & E
C/Martinez Villergas 2
28027 Madrid, Spain
Tel: 34 1 402200

Sweden
Philips forsaljning AB
Customer Support
Tegeluddvagen 1
S-11584 Stockholm
Tel: 46 8 7821000

Switzerland
Philips AG Technischer Kundendienst
Allmendstrasse 140
Postfach 670
CH-8027 Zurich
Switzerland
Tel: 41 1 4882211

Taiwan
Schmidt Electronics Corp.
5th Floor, Cathay Min Sheng
Commercial Building
344 Min Sheng East Road
Taipei, Taiwan, R.O.C.
Tel: 886 2 5013468

Thailand
Measuretronix Ltd.
2102/63 Ramkamhaeng Rd.
Bangkok, 10240 Thailand
Tel: 66 2 3742516

Turkey
Erkman Elektronik Aletler
Ticaret Anonim Sirketi
Necatiby Cad 92/3
Karakoy, Istanbul, Turkey
Tel: 441546

Turk Philips Ticaret A.S.
Posta Kutusu 504 Beyoglu
Inonu Caddesi 78/80
Istanbul, Turkey
Tel: 90 1 1435910

Uruguay
Coasin Uruguaya S.A
Casilla de Correo 1400
Libertad 2529
Montevideo, Uruguay
Tel: 598 2 789015

Venezuela
Coasin C.A.
Calle 9 Con Calle 4
Edif. Edinurbi
Apartado de Correos
Nr-70 136 Los Ruices
Caracas 1070-A, Venezuela
Tel: 58 2 241-0309

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Rockville, MD 20852
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Metro West Industrial Park
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